Evolution of the “Panel System”

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The need for a big-city system using mechanical switching and the probable economies resulting from its use were well known by the middle of 1905. The problems also were fully appreciated and appeared almost insurmountable. When Molina’s translation and registration scheme promised to solve one of the major problems, it was decided early in 1906 to go ahead with development.

Since no other way for handling the manual-machine interconnecting problem existed, the basic plan at this time, and for several years to come, was to concentrate on a semimechanical scheme using automatic distribution of calls to “A” operators who would set up the calls on keysets for mechanical completion through the switches that replaced the “B” operators and hopefully would give faster service than the best manual system.

The first effort went into developing a large switch since this probably would be responsible for a major part of the system cost. By March 1906, Western Electric engineers had designed two rotary switches, one a 200-point (20 around and ten up) selector and the other a 306-point (34 around and 9 up) selector.

In examining the manner in which they would be used in a system, it was apparent that conventional means for multiplying these switches would involve large amounts of cabling at a prohibitive cost. It was at this time that the unique approach was adopted of setting up two separate design groups for developing competing ways of using the registration and translation system for large-city systems. One of these groups continued with the rotary-type switch and devised a special flat-woven cable to provide simpler and more economical multiplying. The other devised a linear switch (later known as the “panel bank”) that employed punched metallic strips to serve both as contact points and connections between points, thus obviating much of the need for cable multiples.

In June of 1907 the two schemes were reviewed in an effort to decide on a system incorporating the best features of each. The time was not ripe for such a decision and parallel development of the two systems was continued during the next few years with frequent review and interexchange of ideas. Desirable features of each system were incorporated in the other. From the beginning, registration and translation in a sender had been a basic part of each system and each also employed power drive for the switches, but there were many differences. The fundamental trunking plans differed and since that devised for the panel system seemed superior, it was applied to the rotary system. The group developing the

rotary system had devised revertive control, multiple brushes with selective tripping, and the rotary sequence switch, all of which were adapted for use in the panel system. Thus, within a short time the two systems were fundamentally the same, differing only in those particulars governed by the differences in the switching mechanism.

By the middle of the 1908, developments had advanced far enough to permit the field trial of a semimechanical system in the form of a PBX. This trial system was cut into service at 463 West Street, New York City, on November 29, 1910, and operated with satisfactory results. At this time the development of the rotary switch mechanism was further advanced than the panel switch and it was used in the trial PBX. It was also used in the system manufactured by Western Electric in Europe about 1911 in answer to the strong competition of other mechanical systems. Largely as a result of this offering, the rotary system has received large use in Europe. However, in 1911, there was still doubt that the rotary system was the best answer for the large-city conditions existing in the United States even though it appeared adequate for the smaller installations required abroad. Further studies were made that, by 1912, showed the panel system had a potential for better serving the large trunk groups associated with the rapid telephone development being experienced in the big cities of the U.S.A. Consequently, all further development effort was concentrated on this system for Bell use.

After a trial of the panel switch in the West Street PBX, it was decided in 1913 that the panel system was ready for large-scale field trials. Although full mechanical switching employing panel selectors was operating in the laboratory at the time, semiautomatic operation was selected for field trial since it could be used for a large-scale trial of the essential elements of the system in a large city without the complication and ambiguities involved in simultaneously introducing dial by the subscriber. It would also provide more flexibility in modifying or adding to the equipment as the trial progressed. A further decision was to separate the trials of the mechanical switching and automatic call distribution in order to expedite the trials and better evaluate the benefits of the two functions.

Equipment to implement the field trials was designed and built by Western Electric to provide semimechanical switching in two Newark, New Jersey offices. The mulberry office with 3,640 equipped lines was placed in commercial service on January 16, 1915, and the Waverly office with 6,480 lines was cut over on June 12 of the same year. These offices worked in association with manual offices in the area and two tandem offices. Beginning in April 1917, automatic call distribution was tested in another semimechanical office in Newark, Branch Brook, which was equipped for 7,400 lines. Two months earlier, a manual office with automatic call distribution had been cut into commercial service in Wilmington, Delaware.

While mechanical switching trials were being conducted, operation and maintenance were extensively studied. Operating loads were not entirely up to expectation but the trials in other respects were highly successful and demonstrated that panel equipment could be depended upon to give high-quality, reliable service in an area where the requirements were as severe as any in the world. At the same time as these field trials were made, work was being carried out in the laboratory on adopting the equipment for customer dialing (i.e., full

mechanical switching) and extensive cost and service studies were made of manual, semimechanical, and full mechanical systems when used in cities of various sizes. The mechanical systems studied included not only panel but also the step-by-step system of Automatic Electric Company and the Clement system manufactured by Northern Electric. As previously noted, patent agreements had been made during 1916 with both of these companies.

As a result of this work, much of the material was at hand in early 1917 for making definite recommendations relative to the use of machine switching in the Bell System. In some areas the labor situation was becoming desperate because the vast expansion of industry, resulting from World War I, was not only increasing labor costs but greatly reducing labor availability. As a result, a memorandum for J. J. Carty, then AT&T Co Chief Engineer, was prepared under the date of July 24, 1917, making recommendations for all-size offices as follows:

Single-office cities—continue with manual switchboards in most such cities, deciding after the completion of trials in progress whether or not automatic call distribution to the answering operator should be used. The chief reason for the recommendation was that speed of service and accuracy were essentially the same for the two systems and cost favored manual at 1916 salary levels and would break even with machine at a 25% increase. Growth could be cheaper for manual, particularly if machine replacements elsewhere made excess manual positions available. The availability of labor was not controlling in most small cities and machine switching systems could be considered where labor was an important consideration.

Multi-office cities not in large metropolitan areas—Adopt a full mechanical system for all growth and convert existing equipment as rapidly as practical (probably in about seven years on the average). Principal reasons for the recommendation were the improved speed of service on trunked calls, reduction in errors, improved economy, and difficulty in obtaining adequate labor supply for full manual operation. At the rate of conversion recommended, no need for dismissing employees would arise. Means for handling the addition and conversion of offices were available but some problems had to be solved before handling message-rate service on four-party lines.

Metropolitan areas such as New York, Philadelphia, Chicago, etc— Use semiautomatic system for all growth and conversion of existing manual systems, but with a 15- to 20-year period for replacement rather than the shorter period recommended for the smaller offices. A full mechanical system was considered to be more desirable for all reasons except those arising from the need for seven-digit dialing. The semimechanical system would avoid these problems and most of the central-office equipment could be utilized later for full mechanical switching if and when the customer dialing problem was solved. In the meantime, semimechanical systems would give speed of service equal to manual, improved accuracy, reduced cost, and ameliorate the labor problem to some extent by reducing the need for operators by about 30 to 40 percent and eliminating some of the more boring and burdensome parts of their work. It was believed that the latter aspects would reduce the turnover of operators.

PBX service—Make available semimechanical private branch exchanges on a provisional basis until experience with this equipment in the hands of the public demonstrated more clearly the advisability of full mechanization.

An interesting theme running through this memorandum is the question of customer acceptability. Not so many years before, many telephone people were uncertain that the public would accept the added burden of dialing. However, experience had shown that customer sentiment ran strongly in favor of dialing, one reason being that they believed it provided much faster service since, being occupied during dialing, they tended to ignore the time required for dialing. Thus, in 1917, ther was no longer a question about the acceptability of dialing but, on the contrary, there was considerable concern over the adverse reaction of those customers who, of necessity, would have to continue with what they may consider the less-modern manual system even though the actual service in many cases would be quite comparable.

The recommendations of the July memorandum were approved by top management of AT&T Co in a letter to Carty on September 13, 1917. By a strange quirk of fate, about the time that this letter was being written, Blauvelt proposed his three-letter, four-number system which would eliminate the reservations on full mechanical systems in metropolitan areas. As a consequence of further work on his proposal, plans were approved in November 1918 for designing the first metropolitan machine office for customer dialing and all subsequent work was on full mechanical systems with one exception. As early as 1916, the New York Telephone Company was in need of an additional tandem office to supplement the three manual tandems then in use. The need was acute because of the large growth of suburban traffic requiring expensive and inefficiently used trunks if handled by means of direct trunking. Tandem trunking greatly reduced the cost of outside plant but increased the error rate since the operating practice in use at the time required a repetition of the number at the tandem office. For this reason, and because of congestion in the trunk multiple of the tandem boards, it was decided in September 1917 to make the new tandem office a semimechanical installation. Work on this New York City office, known as a metropolitan tandem and located in the Walker-Lispenard building, was started in early 1918 and it was placed in service in the middle of 1920. The use of the semimechanical system reduced the errors, as compared to manual tandem, because it eliminated one repetition of the called number. In addition, it provided an important step toward further mechanization by furnishing a highly useful link in the interconnection of manual and machine offices. Both of these advantages will become apparent subsequently.

Unfortunately, the ambitious program for introducing mechanical systems planned in 1917-18 was negated by the United States' entry into World War I on April 6, 1917. By the time the decision to proceed had been made, employees were beginning to join the military services and large parts of the development and manufacturing organizations were beginning to concentrate effort on war projects. On August 15, 1918, the Postmaster General (who was given control of all communication during the war and remained in charge until July 31, 1919) ordered all telephone companies "to confine extensions and betterments to imperative and unavoidable work to meet the war requirements and the vital commercial needs of the country." Following the end of the war there was an acute shortage of labor, and unprecedented increase in cost, and a great deficiency of all kinds of telephone plant, which had to be supplied in the quickest way possible. It was not a favorable atmosphere

for introducing new types of equipment and, as a result, the first full mechanical panel office (the Atlantic office in Omaha, Nebraska) was not cut over to service until December 14, 1922. Growth of panel continued at the rate of about 100,000 lines a year through 1926, after which it increased more rapidly, reaching a rate of nearly 400,000 lines a year by 1931.

Implementation of the Panel System

Basic plan — The basic plan of the panel system under went some changes in the early years but by 1923 the basic scheme used for a full machine connection was as diagrammed in fig 6-55. This bears some resemblance to the ste-by-step system in that both are of the progressive type using a number of switches in tandem. However, they differ basically in that the panel system uses larger switches controlled by a sender. Because these switches give access to many outputs, fewer are required in tandem.

These switches will be described shortly. For an understanding of the manner in which a machine call is set up it is only necessary to know that the switches consist of hundreds of contact points in vertical columns and that the switch arm (commonly called a Selector) is a rod which moves vertically and has access to any of the points along the line of motion. Progress of the call on a full machine connection is as follows:

1. Subscriber lines are connected to switchpoints in a line finder frame and when the receiver is removed from the switchhook, preparatory to dialing, a switch arm is actuated on this frame and moves vertically to select the caller's line.

2. At the same time, the switch arm is connected to a sender through an associated sender selector.

3. Upon completion of these operations, which take only a short time, a "dial tone" is sent to the caller indicating that the machinery is ready to accept dial pulses.

4. When the subscriber dials, their decimal-type pulses are registered in the sender and translated into the signals required for controlling the subsequent selectors, which operate on a non-decimal basis.

5. As a first step in the switching process, the sender causes the particular "district selector" (which is permanently associated with the line-finder selector used) to select a trunk to the office desired.

If the call is for a subscriber in the same office, the trunk chosen will be an internal one terminating at an "incoming selector" frame and the sender will cause the call to be routed through the incoming selector to a final selector and thence to the particular line desired. When the connection is thus completed, audible signals will be sent back to the calling subscriber to indicate that the station is being rung or that the line is busy. In either case the sender is released from the call and becomes available for use on another.

For calls to a subscriber in another machine office, two alternative exist for completing the call over direct trunks. If the trunking network is small, the district selector will connect

an external trunk to the distant office. If, as more likely the network is large, with many interoffice trunks, the district frame, despite its large access, will be routed to an additional switching stage through the office frames that are provided in sufficient numbers to give access to all the outgoing trunks. The outgoing interoffice trunks (regardless of routing in the originating office) terminate at incoming frames at the distant office and connection is made to the called subscriber through these and the final frames as described previously.

Connection between the machine and manual network will be described later. For the present, it suffices to say that it is unnecessary for either the caller or the manual "A" operator to know the type of office in which the call terminates. Regardless of the type of office in which a caller is located, the procedure is the same for calls to either type of called office. Manual "B" operating procedure is basically the same on calls incoming from manual and machine offices with the exception that the desired number is received aurally in the former case and by means of a visual display if from a machine office.

Machine switching does not require radical changes in private branch exchanges. The PBX is provided with dials, and calls to the central office are dialed by the attendant or by the extension user in the same way as the ordinary subscriber dials. No change is required for handling incoming calls, the PBX trunk in a machine office being treated very much in the same way as an individual subscriber line except that the final selector automatically passes over busy PBX trunks and connects to the first one found idle. At the PBX the incoming call from a machine office reaches the attendant in the usual manner and is handled by them in the same way as one from a manual office. After this broad overview of the way in which panel machine-switching functions, we can examine the equpiment used and better understand the design features developed to implement the system plan.